PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Injection Moulding Machines

We, TURNER MACHINERY LIMITED, a British Company, of Bramley, Leeds 13, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to plastic injection moulding machines of the general type incorporating an injection nozzle which is supplied with plasticised material and is adapted to inject this under pressure into a mould in the production of one or more mouldings at a time.

In the most common form of injection moulding machine of this character, i.e. those of the "in-line" type, the mould is made up of two cooperating parts, e.g. male and female parts, which are disposed in axial alignment with the nozzle of an injection cylinder and are locked together and presented to this nozzle for performance of the injection. Such machines will hereinafter be termed "of the kind referred to".

In a conventional form of injection moulding press of this kind, one mould part (usually a female part) is arranged on a fixed plate or headstock upstanding from a machine frame, whilst the other mould part (thus, usually a male part) is mounted on a second plate, parallel to the headstock plate and movable to close and open the mould. The injection cylinder is disposed in axial alignment with the mould parts at the opposite side of the headstock and can in some instances be closed against the latter for the injection to take place.

This simple system has, however, a number of limitations. In the first place there must be provision for sufficient clearance between the mould parts to allow the latter to be opened and the moulding ejected or removed between them—and this, in the case of large articles, means a press with a large daylight and considerable demands of space. It also means a loss of time between injection strokes, and consequent reduction in output.

A further time loss may be inescapable in using this system if the moulding has to be cooled, or if it is to be marked, machined or otherwise treated before it can be removed from the mould. In the latter event, too, the fact that these operations have to take place in the daylight of the press involves additional difficulty and complication in view of the conflicting demands on space.

This invention has been devised with the object of meeting these difficulties, and has done so in a simple yet effective fashion, without elaborate extra equipment, and with attendant further advantages.

To this end, in fact, in this invention we provide a machine of the kind referred to in which there is a single stationary mould part of one kind (e.g. female or male) and a plurality of movable mould parts of a form complementary to said single stationary mould part (e.g. male or female) said plurality being mounted around a carrier which can be rotated stepwise in one direction to move each of its movable mould parts into a plurality of successive stations, in one of which is registers with the stationary mould part for cooperation with the latter in the performance of an injection moulding step.

Thus there are, in effect, a group of movable mould parts which are individually brought in turn into cooperation with the single common complementary stationary mould part and, after each injection stroke, the parts of the then mould are separated to allow the movable mould part on the carrier to remove the moulding out of the

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moulding zone and away from the stationary part, with advantages which will be quickly seen.

Chief of these is the considerable saving of time, due to the facts that

(a) the cooling of the moulding can take place whilst the machine is usefully working, i.e. during a period in which one or more succeeding articles are being formed in the single stationary part,

(b) the distance of separation between the mould parts needs only to be enough for the moulding to clear the stationary part,

(c) the performance of ancillary operations, e.g. sprue removal, ejection, machining, etc., can be carried out on the moulding whilst it is still on the carrier and without the next moulding operation being delayed.

The allied economy in space will also be readily appreciated, and other attributes will appear hereafter.

The foregoing indicates the advantage of the arrangement by which the mould component on the carrier shall withdraw, or be left with, the moulding when the co-operating mould parts are separated. This is very conveniently accomplished where these components are male mould parts or cores and, for the sake of clarity of description only, this will be assumed from here on.

Further, reference has been confined above to the use of a "stationary" single mould part, but again it is to be clearly understood that, in the present specification, this word is intended to refer only to the relative inaction of this part when the moulding is being carried off from the moulding zone by the carrier and its failure then to accompany this carrier. It is not intended to exclude the possibility, for example, that this "stationary" part may move axially to effect, or assist, the axial closure together or opening of registering mould parts or sprue removal after a moulding step.

Again reference has been made above to a "single" stationary mould part, but this is to be interpreted in this specification as including not only the one component of a single- or multi-impression mould, but even a unitary assembly of stationary parts, e.g. two cavities arranged side by side and arranged to cooperate with successive pairs of cores on the carrier, or to cooperate in turn with each of the successive movable mould parts on this carrier.

Thus, in general, when reference is made hereinafter in the claims to a "single stationary mould part", this can include more than one element which, however, cooperates in turn with a larger number of different complementary elements; it can also include one or more elements which is or are not fixed in the machine in the absolute sense, but which cannot accompany the complementary elements throughout their cyclic travel to and through the moulding zone.

The mounting of the carrier for rotation to substitute the male mould parts in turn in the moulding zone is not only relatively simple to implement, e.g. by using a circular or other plate as the carrier and mounting it on a tie or guide rod of the machine, but it enables maximum use to be made of available space and capacity. A relatively large number of male mould parts can thus be confined within a relatively small area, can be brought rapidly into moulding position, and yet can move through subsequent stations, clear of the moulding area, which are convenient for additional operations on the moulded product.

Where a rotary plate is used as the carrier it can be turned by any appropriate means, preferably correlated with other machine operations—and particularly the injection stroke.

Again, such a plate will be mounted on any suitable existing or specially-provided bearing in the daylight of the press. In one advantageous arrangement which has been developed, this plate is rotatably mounted at its centre on the upper and central tie bar of three such bars arranged in triangular formation and secured between the fixed headstock and the fixed tailstock of the machine—a symmetrical arrangement which is found to make a relatively large moulding area available, allied with a well-balanced distribution of the thrusts developed at the injection stroke.

Further, the movable mould parts will best be detachably secured to the carrier, this conferring a number of advantages. In he first place it allows for use of the machine without a full group of male parts necessarily being available (e.g. owing to the exigencies of time in fabricating such parts, for repair thereof, and so on), the periodicity of the injection strokes of the machine being controlled accordingly. A second advantage is that the actual form of the carrier mould parts may be varied from one to another as required so that the machine can be utilised to mould different articles in the same working cycle, and thus be exploited to a maximum according to prevailing demand.

An injection moulding machine incorporating the principles of the present invention is illustrated, by way of example, in the accompanying drawings, in which:—

Figure 1 is a diagrammatic side elevation of this machine.

Figure 2 is a vertical cross section through the central part of this machine and the mould assembly at this part.

Figure 3 is a horizontal cross section, taken on the line III—III of Figure 2, and

Figure 4 is an end view of part of the mechanism seen in Figure 2, as seen from the plane of line IV—IV in the latter.

The injection moulding machine illustrated generally in Figure 1 is of "in line" form, the injection takes place horizontally, and the movements of closing and opening the effective mould are likewise carried out on a horizontal axis.

Parts of this machine which are of generally known form will not be described in detail. One such part is the injector cylinder 2, which has internally a plastic-feeding and -preplasticising screw (an end part only of which is seen at 3) supplied with solid plastics material from a hopper 4 and rotated by an electric motor 5 through gearing generally designated 6. A piston/cylinder unit 7 serves to produce the reciprocation of the screw 3 for each injection shot. The injection cylinder 2 terminates in an injection nozzle 8 which is received in an orifice 9 in a headstock 10 which stands vertically up from the machine frame 1.

At the other end of the machine a vertical tailstock plate 15 is fixed on the frame 1, and this serves as a means to support the mechanism for closing and opening the moulds at the injection station. The headstock 10 and the tailstock 15 are braced together by powerful tie rods 16, 17, 18, of which the rod 16 is disposed at a central medial position in relation to the frame 1 and connects the upper parts of the headstock and tailstock, whilst the rods 17 and 18 are disposed at a lower position towards the sides of the table. The rods are secured by lock nuts 19. This triangular arrangement of the tie rods is found to give a very stable form of mounting capable of sustaining heavy injection pressures without distortion of the machine parts. Further, as will be described below, this selection of the position of the upper tie rod 16 provides an advantageous mounting for the carrier plate.

The tie rods 16, 17, 18 also serve for the mounting of the means for closing the moulds and locking them under pressure. In the present case these means comprise a backing plate 20 for the closed mould (see below) and a thrust plate 21, both these being apertured and slidable on the tie rods. The thrust plate 21 serves for the mounting of the leading end of a multiple toggle linkage or mechanism, generally denoted 22, for clamping and locking the mould under pressure, this mechanism 22 being pivoted at its other end to a plate 23 which is movable under the compulsion of the rod (not shown) of a hydraulic piston/cylinder unit 24 extending rearwards from the tailstock 15, as illustrated in Figure 1.

The thrust plate 21 is connected to the backing plate 20 through a powerful screw 25 so that, in response to appropriate application of pressure fluid, usually oil, to the cylinder 24, the toggle mechanism 22 is straightened or collapsed, in known fashion, to respectively project or retract the plate 20. The screw 25 is received in a nut 26 on the plate 21 and carries a toothed crown 27 at its forward end meshing with a pinion 28 in a housing 29 at the rear of the backing plate 20. The pinion 28 has a head 30 which can be engaged by a tool to turn the screw 25 thus varying the starting position of the backing plate 20, and hence the movable part of the mould system (see below) relatively to the tailstock 15 and the headstock 10, thereby catering for different depths of mould.

The mould assembly, generally designated 31 in Figure 1, shown in more detail in Figures 2—4, and arranged between the backing plate 20 and the headstock 10, is constructed in accordance with the principles of the present invention, and will now be described.

In general it comprises a stepwise rotatable and axially reciprocable mould carrier with a plurality of male mould parts, in this case cores, which cooperate in turn, and in accordance with the indexing of the carrier plate, with a single stationary female mould part.

In the first place the headstock plate 10 has bolted thereto, at the injection zone represented by the orifice 9, a stationary mould part 11. In the specific illustration chosen, it is assumed that articles are to be of simple cup form, as typified by that marked 12 in the drawings, and for this purpose the mould part 11 is of female form with a cavity 13 communicating through a sprue channel 14 to the outlet from the injection nozzle 8 when the latter is in operative position, as seen in Figure 2.

The cores which cooperate in turn with the female part 11, are designated 32, and are four in number, being bolted in a ring around a circular steel carrier plate 33 which has a bearing sleeve 34 rotatably mounted on the upper tie rod 16. The bearing sleeve 34 passes through a corresponding aperture in the backing plate 20 and is secured against axial movement relatively to the latter by nuts 35. A ring 36 is provided between the plate 33 and the backing plate 20 and is ducted to provide for the flow of cooling water from an inlet channel 37 in the backing plate 20 to channels 38 connected by flexible tubing (not shown) to the various moulds. Return channels, of which 39 (see Figure 2) is typical, provide for the return flow of this cooling water.

The carrier plate 33 is intermittently rotatable to move the cores 32 through successive stations, and for this purpose is toothed at its periphery 40 and the drive is imparted thereto through a toothed reduction gearing, comprising pinions 41, 42 and 43, from a rotary fluid motor 44, the shaft of which carries the pinion 43.

The starting and stopping of the motor 44, and hence the stepwise rotation or indexing of the carrier plate 33, is governed from a switch mechanism, generally designated 45, provided at an appropriate position on a lateral bracket 46 serving also to mount the motor 44 and the transmission gearing 41, 42 and 43. Associated with each core position on the carrier plate 33 is a cam piece 47 which is adapted to operate the switch mechanism 45 on arrival thereat. This switch actuation is used not only to arrest the operation of the carrier-plate rotating motor 44 but, as will be mentioned below, also to initiate other functions in the moulding machine, including the opening and closing of a mould by operation of the toggle unit 22, the application of the injection shot from the injector 2, and various actions on the moulded article. The implementation of these controls is well known in the art and will not therefore be described.

As will be appreciated, it is necessary to ensure a precise arrest of the carrier plate 33 on each occasion, and for this purpose the tapered tip of an index locking pin 48 cooperates with holes 49 in the plate in the correct arrest positions. This locking pin 48 is operable by a piston cylinder unit 50 to which the fluid supply is controlled by a valve (not shown) under the command of the switch mechanism 45.

As indicated above, in the particular arrangement illustrated in the drawings, the carrier plate 33 is equipped with four mould cores 32, and it is consequently designed for arrest at four stations which have been designated A, B, C and D in Figure 4. Station A is the injection station and the ejection of the moulding takes place at station D. Stations B and C can be used for a variety of purposes and, typical of these, it is assumed that station C is used for the removal of sprue from each moulding 12, as will be described below. Station B, which could have various uses, is here assumed to be merely left spare for cooling of the moulding.

The sequence of operations, in respect of each particular mould core 32 is therefore as follows.

On arrival and arrest of the core at the injection station A, the toggle mechanism 22 is straightened to shift the movable part of assembly 31 horizontally on the tie rods 16, 17, 18 with the effect, inter alia, of introducing the core 32 concerned into the cavity 13 of the common female mould part 11, whereupon the injector 2 is brought automatically into operation to dispense a shot of plastic into the moulding gap between these two mould parts. To brace the parts in the injection zone against the pressure applied at this time, it will be noted that a pressure plate 51 is disposed at this zone between the backing plate 20 and the carrier plate 33, this pressure plate carrying a fixed segmental claw 52, which runs in a corresponding groove 53 in the carrier plate, to inhibit any tendency to twisting or deformation of the carrier plate under stress at this time. This arrangement also braces the carrier plate 33 when the moulds are opened.

After a pause while the injector cylinder 2 is retracted, the toggle mechanism 22 is collapsed so pulling back the backing plate 20 and with it the movable part of assembly 31. The moulding 12 having, by this time, already shrunken on the core 32, it is retracted with the latter, leaving the female mould cavity 13 clear for the introduction of the core 32 arriving opposite it after the next indexing step.

It is to be noted that only a small amount of axial travel, corresponding to little more than the depth of the moulding itself, is required to clear the moulding, and the core 32 carrying it, completely from the female mould part 11 and thereby to allow the carrier plate 33 to rotate on without obstruction.

The motor 44 is next actuated, to rotate the carrier plate through its next step, by switch means (not shown but well known in the art) operated in response to the retraction of thrust plate 21. The motor 44 is then stopped again by the appropriate cam 47 reaching the switch mechanism 45, this in turn initiating the re-straightening of the toggle mechanism 22 and the initiation of a fresh moulding operation. In the meantime the first moulding 12 under consideration has reached the station B and is idle at this station and left for cooling during this next repetition of the mould opening and closing procedure.

The following indexing step of the carrier plate brings the first moulding 12 to station C. Here it is acted on by a rotary cutter 54 on the headstock 10, which is operable by a piston/cylinder unit 55, under control of switch mechanism 45, to move in and trim the sprue 56 from the moulding. In an alternative arrangement a heated plunger could replace the cutter 54 and melt off the sprue.

Then, after the repetition of the axial reciprocation of the carrier plate 33 and rotation of the latter through the following step, the original moulding 12 is brought to the ejection station D. It will be noted that, at

this station, the core 32 concerned lies opposite a laterally-recessed section 57 of the headstock 10. Also, at this position, this core 32 is lined up with a hydraulic ejector unit 58 mounted on the backing plate 20. The plunger 59 of unit 58 has a reduced head 60 which is thus brought into alignment with a headed ejector pin 61 provided in the male mould part 32, as in all the others. Operation of the switch mechanism 45 at the time of each arrest of the carrier plate 33 is also arranged to cause operation of the unit 58, whereby the moulded article 12 is pushed off its parent core 32 (see Figure 3) into recess 57. An ejector ring (not shown) may also be provided on the cores themselves to assist this action and further means (also not shown) can be provided for collecting the mouldings 12 so ejected.

As will be appreciated the machine described is completely automatic, performing the cycles of mould closure and locking, closing up the injection nozzle 8 to the mould, producing the injection, removal of the nozzle, opening of the mould, and indexing of the carrier plate to bring in a new male mould part, in that order, followed by repetitions of the cycle.

As instanced by the sprue-trimming means 54, 55, the machine may be equipped at stations around the carrier plate, with apparatus for performing various ancillary operations on the moulding in timed relation with the mould closure and injection referred to above, for example general trimming, piercing, cutting, diestamping, removal and replacement of inserts, and machining and unscrewing of the mouldings, as well as affording cooling time. The number of stations made available for these procedures can, of course, be varied as required.

In general, the machines in accordance with this present invention are applicable to the production of many forms of mouldings, of which thin-walled cup-form containers of most shapes and sizes are a typical and eminently suitable example. Other examples are screw caps and many kinds of insert mouldings.

As will be clear from the foregoing, a machine according to this invention has, inter alia, the following advantages:—

(a) There is an increased rate of production due to elimination of much of the cooling, ejection and removal times which have to be allowed for in a standard injection moulding machine.

(b) It can be relatively compact because it is only necessary to open the daylight wide enough to permit the rotation of the carrier into the next position and no clearance for removal of the moulding is needed between the mould parts. This is a further factor in time saving and increase in capacity of the machine.

(c) In comparison with more elaborate machines, for example of the turret type, with a plurality of mould sets, the expensive outlay for moulds is reduced. Only one stationary mould part is required in comparison with the four, six or more which would be required to produce a corresponding result with a turret type of machine.

(d) The machine is quickly adaptable to different uses, by the simple addition of such apparatus as unscrewing devices, insert unloading and reloading apparatus, and devices for effecting marking, trimming and machining operations of various kinds.

(e) The stationary mould part allows, without any difficulty, the incorporation in the apparatus of such auxiliary heating devices as may be required to maintain the plastic hot in the case of hot sprues, hot runners or any type of heated injection nozzle, in contrast to apparatus in which the moulds may be movable as a whole (e.g. rotatable) relatively to the injection nozzle.

WHAT WE CLAIM IS:—

1. An injection moulding machine of the kind referred to, in which there is a single stationary mould part of one kind, and a plurality of movable mould parts of a form complementary to said single stationary mould part, said plurality being mounted around a carrier which can be rotated stepwise in one direction to move each of its movable mould parts into a plurality of successive stations, in one of which it registers with the stationary mould part for cooperation with the latter in the performance of an injection moulding step.

2. An injection moulding machine comprising an upstanding support for a fixed mould part, an injector at one side of this support, a carrier plate rotatable about a horizontal axis at the other side of this support and arranged for the detachable mounting thereon of a plurality of mould parts each complementary to said fixed mould part, and means for rotating said carrier plate so as to move each mould part thereon into at least three stations, including an injection station in which it cooperates with said fixed mould part to define a closed injection mould, and an ejection station in which it is acted on by an ejection means of the machine.

3. In an injection moulding machine a plastics injector with an injection head, a fixed mounting for supporting a stationary cavitied mould part adjacent said head, a carrier in the machine at the opposite side of the fixed mounting to said head and

adapted to receive and operatively support a ring of mould cores capable of individually closing on said cavitied mould part to define an injection mould therewith, means for rotating said carrier stepwise to bring individual mould cores in turn opposite said cavitied mould part, and means for reciprocating said carrier axially to successively close said mould cores individually against the stationary cavitied mould part and then open the closed mould after injection, prior to subsequent stepwise rotation of the mould core with the carrier, carrying the moulded article with it, to an ejection station in the machine.

4. An injection moulding machine comprising a frame, a carrier plate supported on said frame and adapted to support a ring of movable mould parts, means for rotating said carrier plate stepwise through a plurality of stations, a fixed mounting upstanding from said frame opposite said carrier plate, said mounting being formed to receive a stationary mould part at an injection zone, means for moving said carrier plate bodily to and from said mounting to close each movable mould part in turn against said stationary mould part, injector means supported by said frame and directed towards said injection zone, and means mounted at a position remote from said injection zone for ejecting a formed article from the carrier plate on arrival at said station.

5. An injection moulding machine comprising a frame, a fixed headstock and a fixed tailstock upstanding from said frame, tie means between said headstock and tailstock, a carrier plate for a ring of movable mould parts rotatably mounted on said tie means, means for rotating said carrier plate stepwise through a plurality of stations, said headstock being formed to receive a stationary mould part complementary to those on the carrier plate and being recessed opposite an ejection station of said carrier plate remote from the injection zone, means for translating said carrier plate to and from said mounting to close each movable mould part in turn against said stationary mould part, injector means supported by said frame and directed towards said injection zone, and means for ejecting a moulded product from the carrier plate at the ejection station.

6. An injection moulding machine according to Claim 4 or 5, further including control means operable in response to the arrival of the carrier at each successive station to govern the operation of the carrier plate rotating means, the carrier plate translating means, the injector means, and the ejecting means.

7. An injection moulding machine substantially as hereinbefore described with reference to the accompanying drawings.

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PROVISIONAL SPECIFICATION

Injection Moulding Machines

We, TURNER MACHINERY LIMITED, a British Company, of Bramley, Leeds 13, do hereby declare this invention to be described in the following statement:—

This invention relates to machines for fabricating bodies or articles of plastic materials, and more particularly injection moulding machines of the general type incorporating an injection nozzle which is supplied with plasticised material and is adapted to inject this under pressure into a mould in the production of said bodies or articles, one or more at a time.

In the most common form of injection moulding machine of this character, i.e. those of the "in-line" type, the mould is made up of male and female parts to which are disposed in axial alignment with the nozzle of an injection cylinder and are locked together and presented to this nozzle for performance of the injection. Such machines will hereinafter be termed "of the kind referred to".

In a conventional form of injection moulding press, one mould part (usually the female) is arranged on a fixed plate or headstock upstanding from a machine frame, whilst the other mould part (thus, normally the male part) is mounted on a second plate, parallel to the headstock plate and movable in one direction to close the mould parts axially together and in the opposite direction to separate them. The injection cylinder is disposed in axial alignment with the mould parts at the opposite side of the headstock and can in some instances be closed against the latter for the injection to take place.

This simple system has, however, a number of limitations. In the first place there must be provision for sufficient clearance between the mould parts to allow the latter to be opened and the moulding ejected or removed between them—and this, in the case of large articles, means a press with a large daylight and considerable demands on space. It also means a loss of time between injection strokes and consequent reduction in output.

A further time loss may be inescapable in using this system if the moulding has to be cooled, or if it is to be marked, machined or otherwise treated before it can be removed from the mould. In the latter event, too, the fact that these operations

have to take place in the daylight of the press involves additional difficulty and complication in view of the conflicting demands on space.

This invention has been devised with the object of meeting these difficulties, and has done so in a simple yet effective fashion, without elaborate extra equipment, and with attendant further advantages.

To this end, in fact, in this invention we provide a machine of the kind referred to in which there is a single stationary mould part of one kind (i.e. female or male), and a plurality of mould parts of the other kind (i.e. male or female), this plurality being mounted on a carrier which is operable to bring its satellite mould parts in turn into register with the stationary part for co-operation with the latter in performance of an injection moulding step.

Thus there are, in effect, a set of mould parts of one formation which are brought into cooperation in turn with the common complementary stationary unit and, after each injection stroke, the parts of the then mould are separated to allow the formation on the carrier to remove the moulding with advantages which will be quickly seen. Chief of these is the considerable saving of time, due to the facts that

(a) the cooling of each moulding can now take place in its own time and whilst one or more succeeding articles are being formed in the single stationary part,

(b) the distance of separation between the mould parts needs only to be enough for the moulding to clear the stationary part,

(c) the performance of ancillary operations, e.g. sprue removal, machining, etc., on the moulding can be carried out at leisure without the next moulding operation being delayed.

The allied economy in space will also be readily appreciated, and other attributes will appear hereafter.

The foregoing also indicates the prerequisite that the mould components of the carrier shall withdraw, or be left with, the mouldings when the cooperating mould parts are separated. In the majority of cases, this is most conveniently accomplished where these components are male mould parts and, for the sake of clarity of description only, this will be assumed from here on.

Further, reference has been confined above to the use of a "stationary" single (now female) mould part, but again it is to be clearly understood that this word refers only to the relative inaction of this female part when the moulding is being withdrawn by the carrier. It is not intended to exclude the possibility that this female part may move to effect, or assist, the axial closure together or opening of registering mould parts.

Again, reference has been made above to one stationary or female mould part, but this is to be interpreted as including not only a multiple mould part, but even the case where there is more that one stationary part, e.g. two arranged side by side and arranged to cooperate with successive pairs on the carrier.

The carrier can be arranged to move in various ways to present its individual mould components successively in the moulding location, although in all instances it will move, whether with a single or a compound motion, so as to withdraw these in a direction generally transverse to the injection moulding axis. For this purpose, for instance, it may be capable of a transverse reciprocating movement as well as, or instead of, a rotary movement.

In a preferred version, however, the carrier is mounted for rotation to substitute the male mould parts in turn in the moulding zone. Not only is this arrangement relatively simple to implement, e.g. by using a circular or other plate as the carrier and mounting it on a tie or guide rod of the machine, but it enables maximum use to be made of available space and capacity. Hence, a relatively large number of male mould parts can be confined within a relatively small area, can be brought rapidly into moulding position, and yet can move through subsequent stations clear of the moulding area which are convenient for additional operations on the moulded product.

Where a rotary plate is used as the carrier it can be turned by any appropriate means, preferably correlated with other machine operations—and particularly the injection stroke.

Again such a plate will be mounted on any suitable existing or specially-provided bearing in the daylight of the press. In one advantageous arrangement which has been developed this plate is rotatably mounted at its centre on an upper tie bar secured between the fixed headstock and the fixed tailstock of the machine—a symmetrical arrangement which is found to make a relatively large moulding area available, allied with a well-balanced distribution of the thrusts developed at the injection stroke.

By yet another feature of this invention the carrier, especially if a plate, is mounted so that it can be removed at any time to allow the press to be used as a conventional "in-line" machine, for example where it must be wanted to produce extra large mouldings. Conversely the mounting means for the carrier may be such as to be applicable to existing forms of press, thus allowing the latter to be converted into machines according to the present invention.

Further, the individual (assumed male) mould parts may be detachably secured to the carrier, this conferring a number of advantages. In the first place it allows for use of the machine without a full set of male parts necessarily being available (e.g. owing to the exigencies of time in fabricating such parts, for repair thereof, and so on), the injection stroke of the machine being controlled accordingly. A second advantage is that the actual form of the carrier mould parts may be varied from one to another as required so that the machine can be utilized to mould different articles in the same working period, and thus be exploited to its maximum according to prevailing demand.

Finally, it is to be understood that although reference has been made above to presses of the "in-line" type which usually have their injection axes horizontal, the invention is also applicable to injection moulding machines in which this axis is otherwise disposed and, particularly, where it is vertical.

One specific embodiment of an injection moulding machine incorporating the present invention will now be described by way of example.

This machine follows the general pattern of a known form of "in-line" press, in that it comprises a headstock plate and a tailstock plate parallel, upstanding and fixed on the base frame. An injection cylinder containing an injection plunger in the form of a pre-plasticising screw and served from a feed hopper is mounted at the headstock end of the machine in a casing adjoined by the pressure cylinder producing the injection stroke.

In this particular machine the headstock and tailstock are coupled by longitudinal tie rods, viz. an upper rod half-way across the width of the plates and a second and third rod at the lower front and rear corners. Slidable longitudinally on these rods between the tailstock and headstock plates are a toggle plate and a mould-backing plate.

The toggle plate is coupled to the tailstock through a multiple toggle mechanism of known form which is operable by the plunger of a pressure cylinder, mounted on the outer side of the tailstock plate, to lock and unlock the moulds at required times. In turn this toggle plate is connected by a robust control screw and adjusting nut to the mould backing plate, so providing for adjustment of the final positioning of this latter plate relatively to the headstock and hence allowing for variation in mould height.

Rotatably mounted, by means of a central hub on the backing plate and the upper tie bar is the carrier for the male mould elements, this consisting of a circular steel plate which is provided with a ring of regularly-spaced bores detachably receiving male moulding elements or cores. Associated with this carrier plate is an indexing mechanism, which may be automatically- or hand-operated, to bring the male mould elements in turn into register with the common female part. This female mould part, or mould cavity, is mounted centrally in the headstock in axial alignment with the injection plunger and its nozzle.

As will therefore be appreciated the machine can, if required, be made completely automatic, performing the cycles of mould closure and locking (under the compulsion of the toggle cylinder), closing up the injection nozzle, producing the injection, removing the nozzle, opening the mould, rotating the carrier plate to bring in a new male mould part, in that order, followed by repetitions of the cycle.

In addition the machine may be equipped, at stations around the carrier plate, with apparatus for performing various ancillary operations on the moulding in timed relation with the mould closure and injection referred to above, all for instance under the dictation of control mechanism conveniently housed in said bed frame. These operations are, for example, gate removal, general trimming, piercing, cutting, diestamping, removal and replacement of inserts, machining, and unscrewing, as well as the cooling time afforded.

In general, the machines in accordance with this present invention are found applicable to the production of various forms of moulding, of which thin walled containers of most shapes and sizes are a typical and eminently advantageous example. Other examples are screw caps and many kinds of insert mouldings. As will be clear from the foregoing, a machine according to this invention has, inter alia, the following advantages:—

(a) There is an increased rate of production due to elimination of much of the cooling, ejection and removal times which have to be allowed for in a standard injection moulding machine.

(b) It can be relatively compact because it is only necessary to open the daylight wide enough to permit the rotation of the carrier into the next position and no clearance for removal of the moulding is needed between the mould parts. This is a further factor in time saving and increase in capacity of the machine.

(c) Longer mouldings can be produced in relation to the length stroke, in comparison with conventional machines. Thus, for instance, a stroke of 7″ will permit a moulding to be made up to 7″ long, whereas on a normal machine a stroke of this length will normally

only permit, under automatic cycle conditions, the moulding of components up to $3\frac{1}{2}$" long.

(d) In comparison with more advanced machines, for example of the turret type, the number of expensive moulds is reduced. Only one stationary mould part is required in comparison with the four, six or more which would be required to produce a corresponding result with a turret type of machine.

(e) The machine is quickly adaptable to different uses, by the simple addition of such apparatus as unscrewing devices, gate and sprue removal devices, insert unloading and reloading apparatus, and devices for marking, trimming and machining operations of various kinds.

(f) The stationary, or relatively stationary, mould part allows, without any difficulty, the incorporation in the apparatus of such auxiliary heating devices as may be required to maintain the plastic hot in the case of hot sprues, hot runners or any type of heated injection nozzle, in contrast to apparatus in which the moulds may be movable as a whole (e.g. rotatable) relatively to the injection nozzle.

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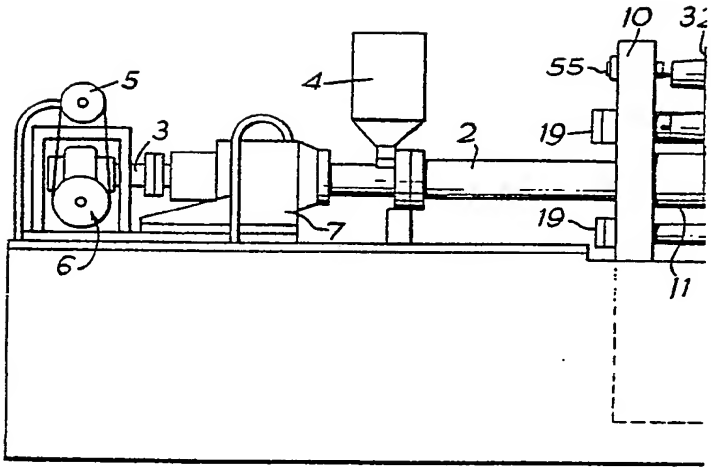
Fig. 1.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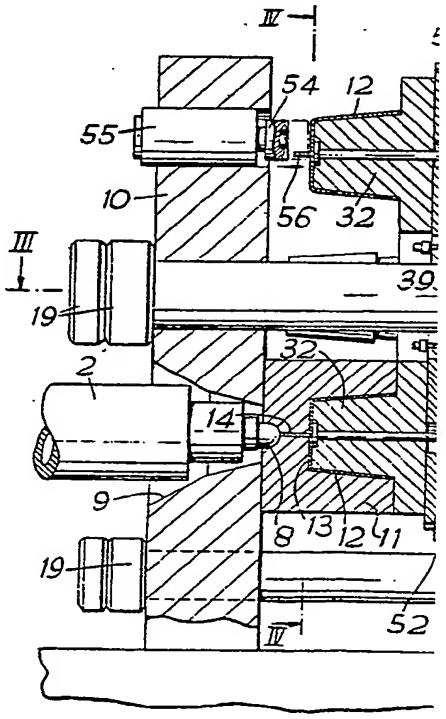
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III
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IV

903298 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

Fig. 1.

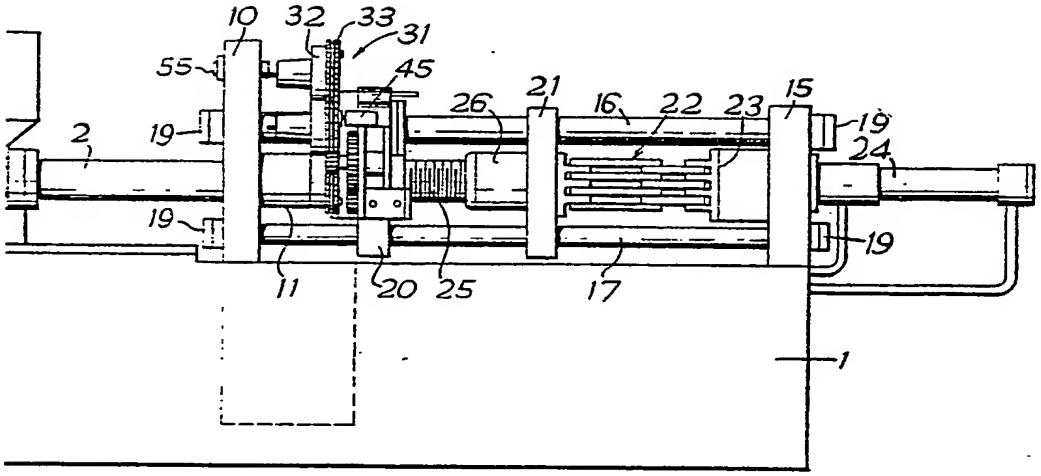
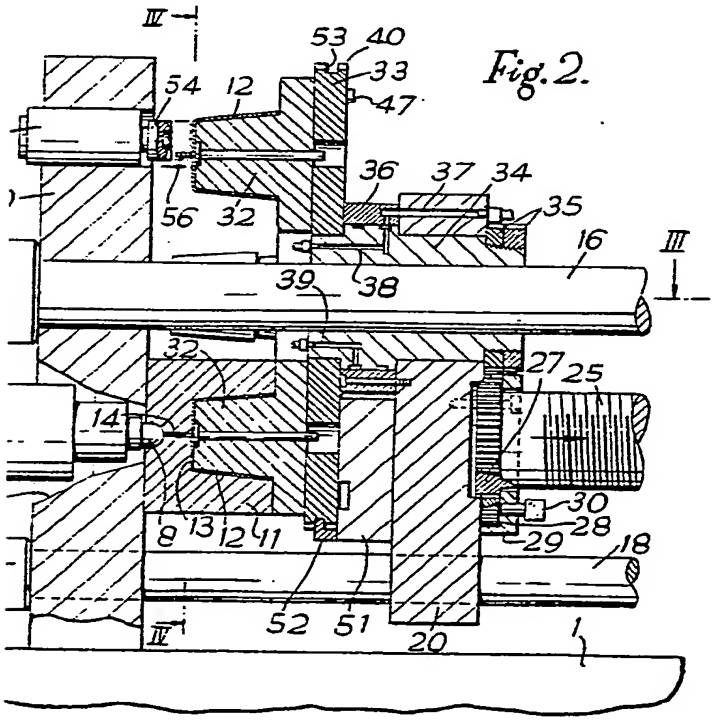


Fig. 2.



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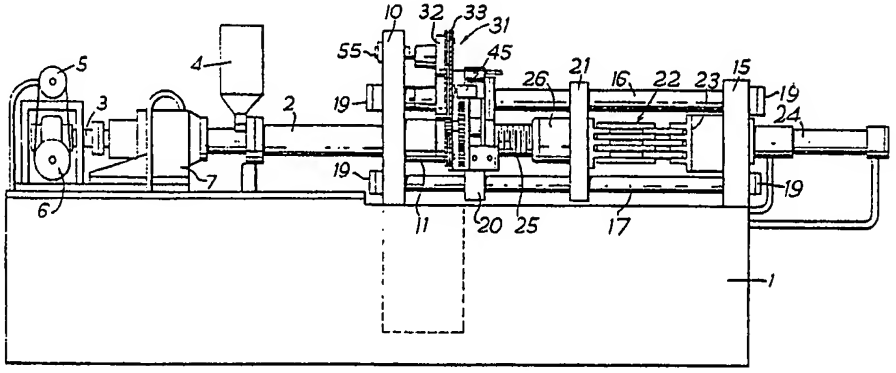

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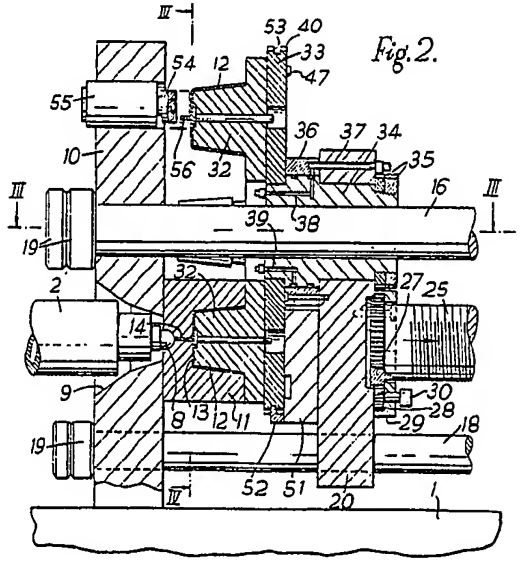

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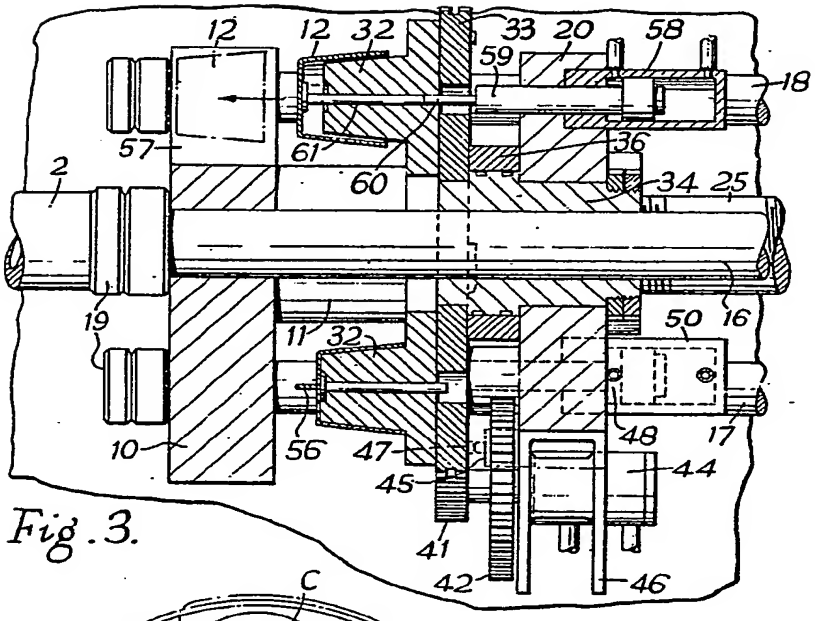

Fig. 3.

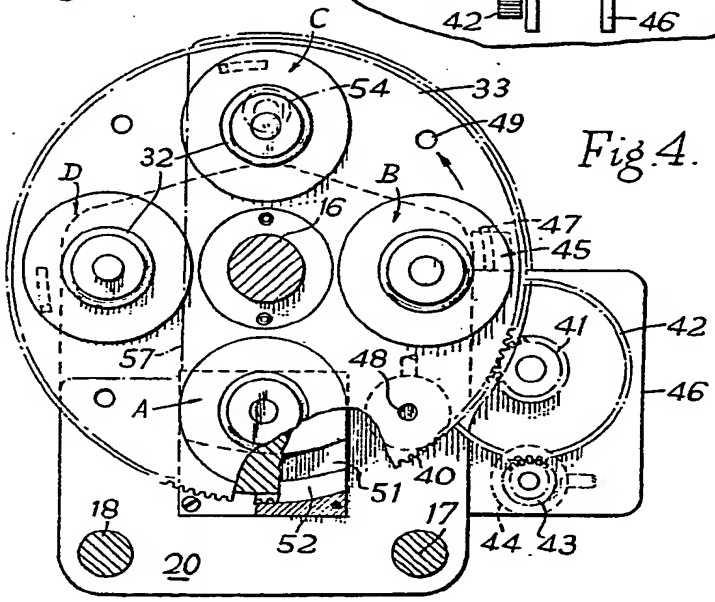

Fig. 4.